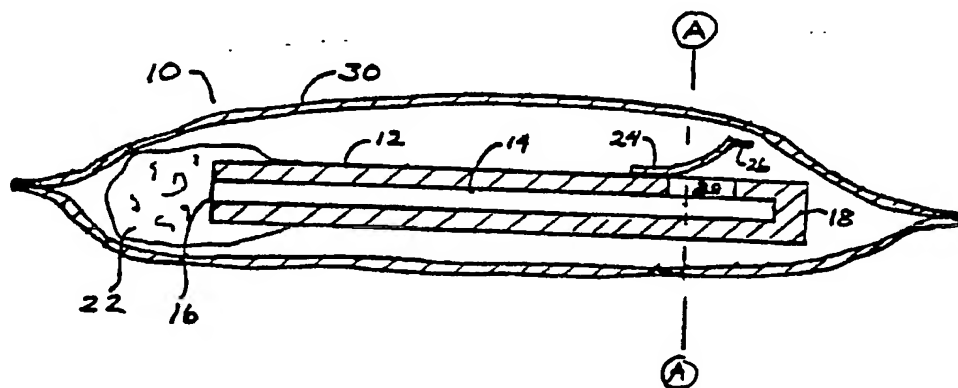


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<b>(21) International Application Number:</b> PCT/US89/01603 <b>(22) International Filing Date:</b> 15 April 1989 (15.04.89) <b>(30) Priority data:</b> 183,586 19 April 1988 (19.04.88) US <b>(71)(72) Applicants and Inventors:</b> NUGENT, William, Michael [US/US]; 907 6th Street, S.W., 312C, Washington, DC 20024 (US). WOLFSON, Harris, Phillip [US/US]; 78 Glen Drive, Sausalito, CA 94966 (US). <b>(74) Common Representative:</b> NUGENT, William, Michael; 907 6th Street, S.W., 312C, Washington, DC 20024 (US).		<b>(81) Designated States:</b> AT (European patent), AU, BE (European patent), BR, CH (European patent), DE (European patent), FI, FR (European patent), GB (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), NO, SE (European patent).  <b>Published</b> <i>With international search report.</i>

**(54) Title:** SATURABLE SWAB APPLICATOR**(57) Abstract**

An applicator (10) and method for dispensing liquids, including a rigid tubular member (12) having a reservoir cavity (14), an absorbent material (22) attached to a first end (16) of the tubular member (12), and a reversible seal (24) at a second end (18) of the tubular member (12). The first end (16) of the tubular member (12) remains open during manufacture and use. A second end (18) of the tubular member (12) initially is unsealed. The first end (16) is immersed in a selected liquid which flows into the reservoir cavity (14) by capillary action. The second end (18) of the tubular member (12) is then sealed by the reversible seal (24) and the first end (16) of the tubular member (12) is removed from the liquid which is retained in the reservoir cavity (14). A swab or sponge of absorbent material (22) is attached to the first end (16) of the reservoir cavity (14). When the applicator (10) is to be used, the second end (18) of the tubular member (12) is unsealed, exposing the liquid to atmospheric pressure causing the liquid to flow rapidly into the swab without applying compressive force to deform the tubular member (12).

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## SATURABLE SWAB APPLICATOR

DESCRIPTIONTechnical Field of th Invention

The pres nt invention relates generally to applicators  
5. for liquid medicaments, dyes, or other solutions. More  
particularly, it relates to applicators having a sponge or  
fibrous absorbent pad attached to at least one end of a fluid  
containing reservoir.

Background Art

10 Applicators for applying medicaments or other solutions  
are known in the art and are discussed in U.S. Patent No.  
3,757,782 to Aiken. As noted in Aiken, such swabs include an  
absorbent material, such as cotton or sponge, attached to one  
or more ends of a hollow and flexible tubular handle. The  
15 handle is filled with the selected liquid and sealed at each  
end to contain the liquid prior to attachment of the absorbent  
material. When the applicator is to be used, the  
flexible handle is compressed, deforming the walls thereof and  
causing the seal nearest the absorbent material to be  
20 ruptured. The compression also causes the liquid to be  
ejected forcibly into the absorbent material to saturate it.

Such swab applicators depend on having a deformable  
tubular member which must be transversely compressed to  
rupture a seal and to eject the liquid into the absorbent  
25 material. Because the tubular member is purposely deformable,  
it is subject to inadvertent application of mechanical force  
sufficient to rupture the seal and saturate the absorbent  
material at a time when it is not desired. The applicators  
may then desiccate and may be rendered useless, resulting in  
30 waste and unnecessary expense.

Such applicators also may not function as rapidly and as  
dependably as desired because they require the user to apply  
compressive mechanical stress to the tubular member. This is  
a particularly important problem when the user is wearing  
35 surgical gloves which may be slippery, thereby increasing the  
likelihood that the pressure that must be exerted on the  
applicator tubular member may cause the applicator to slip  
from the fingers of the user.

The amount of compression necessary also may not be accurately determinable by the user, necessitating repeated attempts to compress the tubular member. This possible unreliability is particularly undesirable when the applicator 5 is used in surgery or in emergency room procedures.

The applicators of the prior art also do not teach means to saturate absorbent material on more than one applicator at the same time by a single action. Such a deficiency may be important in situations, such as emergency rooms or surgical 10 settings, when several or many applicators are needed quickly.

Such applicators also require more than one seal, at least one of which is rupturable. The reduction of the number of seals would have the advantage of reducing cost of manufacturing and therefore reducing the cost to the consumer 15 and of reducing the complexity of the manufacturing process.

Other applicators include those of the ampule type configuration having a constricted sealed end around which a swab is bound, the constricted end being broken to release the contained liquid into the swab. Examples of this type of 20 applicator include U.S. Patent No. 1,221,227 to Schulz and U.S. Patent No. 1,309,201 to Hollister. Such applicators require that the liquid be contained in a completely sealed container and that the liquid be released by gravitational force when the ampule is broken. They do not teach the use of 25 capillary action or pressure differentials to fill the applicators with liquid or surface tension to retain liquids in the applicator, nor do they teach the use of a reservoir open at the swab end and reversibly sealed at the end distal to the swab, as in the present invention.

30 Another known applicator has a resiliently deformable hollow casing in which a wick containing liquid is disposed and which requires squeezing of the casing to force the liquid out. Such an applicator is described in U.S. Patent 3,369,543 to Ronco.

35 Another known type of applicator operates by piston action of a plunger inside a hollow tube containing a liquid, a swab being attached to one end of the hollow tube. The

plunger is pushed into the hollow tube to force the liquid into the swab. Such an applicator is described in U.S. Patent No. 3,519,364 to Truhan.

#### Disclosure of the Invention

5 Accordingly, it is an object of the present invention to provide an improved disposable applicator for liquids such as medicaments, antiseptics, dyes and other solutions.

Another object of the present invention is to provide a disposable applicator for liquids which does not require the  
10 application of compressive mechanical force for use.

Another object of the present invention is to provide a disposable applicator for liquids which reduces the likelihood of inadvertent saturation of an absorbent material.

It is still another object of the present invention to  
15 provide a disposable applicator which operates rapidly and dependably to saturate an absorbent material with a selected liquid.

It is yet another object of the present invention to provide means for simultaneous saturation of the absorbent  
20 materials of more than one applicator.

Broadly stated, the present invention is a saturable swab applicator for applying medicaments, antiseptics, dyes or other solutions to a surface, including a rigid, non-compressible tubular member having a reservoir cavity for  
25 temporarily containing a selected solution, and an open first tubular member end and a closed second tubular member end, an absorbent material being attached to the first tubular member end of the rigid tubular member, reversible sealing means for reversibly sealing an aperture extending radially through the  
30 rigid tubular member which aperture is disposed near the second tubular member end of the rigid tubular member, and antidesiccation means sealing the absorbent material for preventing the solution from drying out.

Preferably, the first tubular member end of the rigid  
35 tubular member is immersed in the liquid selected to be contained therein, prior to the sealing of reversible sealing means of the rigid tubular member. The liquid flows into the

reservoir cavity by capillary action and then the aperture of the rigid tubular member is sealed by reversible sealing means. The tubular member is then extracted from the liquid and a volume of liquid is retained in the reservoir by the pressure differential between the first tubular member end of the reservoir cavity and the second tubular member end of the reservoir cavity. The liquid so contained in the reservoir cavity does not extend to the first tubular member end of the reservoir cavity because the containing force resulting from the pressure differential described above is insufficient to retain all of the liquid which entered the reservoir cavity while the first tubular member end of the reservoir cavity was immersed in the solution. An absorbent material, such as a sponge or fibrous material, is then attached to the first end of the reservoir and an antidesiccation means is applied to the device such that the solution thus contained is not exposed to the drying effects of the atmosphere via the absorbent material.

The present invention preferably includes manifold means for connecting more than one applicator together, such that the absorbent material of each individual applicator may be saturated separately or simultaneously.

#### Brief Description of the Drawings

FIGURE 1A is an enlarged longitudinal cross section of a first embodiment of the present invention.

FIGURE 1B is an enlarged cross section of the first embodiment of the present invention taken at section line A shown in FIGURE 1A.

FIGURE 2 is an enlarged longitudinal cross section of a variation of the first embodiment of an applicator according to the present invention.

FIGURE 3A is an enlarged longitudinal cross section of a second embodiment of the present invention.

FIGURE 3B is an enlarged transverse section of the second embodiment of the present invention taken at section line A shown in FIGURE 3A.

FIGURE 4A is an enlarged longitudinal cross section of a

third embodiment of the present invention.

FIGURE 4B is an enlarged transverse cross section of the third embodiment of the present invention taken at section line A shown in FIGURE 4A showing reversible sealing means in 5 the unsealed position.

FIGURE 4C is an enlarged transverse cross section of the third embodiment of the present invention taken at section line A shown in FIGURE 4A showing the sealing means in the unsealed position.

10 FIGURE 5A is an enlarged longitudinal cross section of a fourth embodiment of an applicator according to the present invention, shown in a sealed position.

FIGURE 5B is an enlarged longitudinal cross section of the fourth embodiment of an applicator according to the 15 present invention, shown in an unsealed position.

FIGURE 6A is a longitudinal cross section of a fifth embodiment of an applicator according to the present invention.

FIGURE 6B is a transverse cross section of the fifth 20 embodiment of an applicator according to the present invention taken at section line A shown in FIGURE 6A showing the sealing means in the sealed position.

FIGURE 7 is a longitudinal cross section of a sixth embodiment of an applicator according to the present 25 invention.

FIGURE 8 is a longitudinal cross section of a seventh embodiment of an applicator according to the present invention.

FIGURE 9 is a side view of a eighth embodiment of an 30 applicator according to the present invention.

FIGURE 10 is a side view showing a ninth embodiment of an applicator according to the present invention.

FIGURES 11A is a longitudinal cross section of a tenth embodiment of an applicator according to the present 35 invention.

FIGURE 11B is a longitudinal cross section of a variation of the tenth embodiment of an applicator according to the

~~present invention.~~

Best Mode for Carrying Out the Invention

With reference to FIGURE 1A, a preferred embodiment of a saturable swab applicator 10 according to the present invention is shown at in longitudinal section view. The applicator 10 includes a rigid tubular member 12 having a longitudinal reservoir cavity 14, an open first tubular member end 16, a closed second tubular member end 18, and an aperture 20 extending radially from reservoir cavity 14 through rigid tubular member 12 to the exterior of applicator 10.

Rigid tubular member 12 may be formed by molding, extruding or other known industrial method applied to a material which results in a rigid, non-compressible tubular member having a relatively small diameter. The material used to form rigid tubular member 12 should be chemically non-reactive with the liquid selected to be contained therein. The diameter of rigid tubular member 12 should be sufficiently small to cause the liquid to flow into reservoir cavity 14 by capillary action when first tubular member end 16 is inserted into the liquid and to be retained in reservoir cavity 14 by surface tension between the liquid and the inner surface of rigid tubular member 12. Typically the inside diameter of rigid tubular member 12 may be one-thirty-second of an inch to one-sixteenth of an inch, but may be more or less, depending on the particular material selected for rigid tubular member 12 and the viscosity and other characteristics of the selected liquid.

Absorbent material 22 is attached by any known means to first tubular member end 16. Absorbent material 22 may be cotton, sponge, or other natural or synthetic fibrous or porous material capable of absorbing liquids.

This embodiment of the present invention also preferably includes reversible sealing means 24. As shown in FIGURE 1A, reversible sealing means 24 may be a flexible material impervious to moisture and air, such as a plastic or metal foil tape, which material may be sealably applied to the exterior surface of rigid tubular member 12 so as to cover and



seal aperture 20. Reversible sealing means 24 preferably is applied to rigid tubular member 12 by use of an adhesive substance therebetween. The selected adhesive should not be chemically reactive with the liquid to be contained in 5 reservoir cavity 14. Reversible sealing means 24 may also include tab means 26 which is continuous therewith and which is not sealed to rigid tubular member 12 and which enables the user of saturable swab applicator 10 easily to pull reversible sealing means 24 from adhesion to rigid tubular member 12 to 10 expose aperture 20 and therefore reservoir cavity 14 and the liquid contained therein to atmospheric pressure.

FIGURE 1B is a transverse cross sectional view of the first embodiment of the present invention taken at section line A shown in FIGURE 1A. Components shown in both FIGURES 15 1A and 1B are numbered alike in both figures.

It is a common experience among people to observe the dynamics of fluids in tubes. For example, it is observed that if a straw of small diameter having two open ends is inserted generally vertically into a container of liquid, capillary 20 action causes the liquid to flow upward into the straw to a certain height limited by atmospheric pressure. If the end of the straw open to the atmosphere is closed, as by applying a finger to the opening, and the straw is lifted from the liquid, a quantity of liquid will remain in the straw by 25 virtue of the pressure differential between the lower open end of the straw and the upper closed end. Some liquid at the lower end may flow out of the straw until the downward forces, such as gravity, are less than the retaining forces resulting from the pressure differential and surface tension in the 30 straw.

The liquid remaining in the straw will be retained until the finger is removed from the upper end of the straw. When that occurs, the pressure at the upper end of the straw and at the lower end of the straw are approximately equal and gravity 35 causes the liquid to flow rapidly out of the lower end of the straw.

If, however, while the upper end of the straw is closed,

a compressive force is applied to the flexible or transversely deformable walls of the straw, the liquid may be ejected from the lower end of the straw despite continued sealing of the upper end of the straw. Such compressive force may be applied accidentally and if applied purposely, may not be sufficient to eject all of the liquid from the straw.

Swab-type applicators in the prior art have included flexibly compressible tubular members which are designed to operate by squeezing the tubes to force the liquid contained therein out from the tube. Commonly, those applicators include a seal or membrane disposed at the end of the tube to which a swab is attached and the seal or membrane is ruptured by the compressive force applied to the tube.

The applicators of the prior art have the disadvantages of being capable of accidental discharge of the liquid by inadvertent compression of the flexible tubes and of being unreliable in that the compressive force required to be applied to the tubes may not be known or applied by the user, resulting in less than full discharge of the liquid into the swab. Moreover, the applicators of the prior art, by requiring a minimum of two seals, one permanent seal distal to the swab and one rupturable seal proximate to the swab, are more complex and more expensive to manufacture than the applicator of the present invention.

Because applicator 10 according to the present invention employs a rigid tubular member and the principles of pressure differentials and surface tension to operate, rather than application of compressive force to deform a flexible tube, the present invention requires that the liquid containing tubular member 12 be rigid so that whatever compressive force might be applied to it purposely or accidentally will not deform rigid tubular member 12.

Moreover, applicator 10 of the present invention does not require the application of compressive force to the contained liquid by pushing a piston into an outer tube, as in some applicators of the prior art. The structure and operation of applicator 10 of the present invention is therefore simpler

and is expensive to manufacture and use than piston-type applicators.

With reference to FIGURES 1A and 1B, applicator 10 and its method of use may be described. Preferably, a liquid is selected to be contained in applicator 10 and placed in a temporary container. The liquid might be alcohol, disinfectant, antiseptic or other medicament for medical uses, or it might be dyes or inks or other liquid for artistic, industrial, cosmetic or other uses. Rigid tubular member 12 has its first tubular member end 16 permanently open and reversible sealing means 24 is initially in an unsealed position.

Reversible sealing means 24 should be an air and moisture impermeable flexible material, such as a plastic or metal tape, and may be adhesively attached at one end 28 to the outer surface of rigid tubular member 12, such that aperture 20 is not sealed.

Reversible sealing means 24 may include an adhesive applied to its face adjacent rigid tubular member 12 so that reversible sealing means 24 may be pressed into adhesive contact with rigid tubular member 12, thereby sealing aperture 20. The adhesive thus used should be chemically non-reactive with rigid tubular member 12 and with the liquid selected to be contained in reservoir cavity 14.

With reversible sealing means 24 in the above described unsealed position and reservoir cavity 14 exposed to atmospheric pressure via aperture 20, the first tubular member end 16 of rigid tubular member 12 preferably is immersed in the selected liquid, the second tubular member end 18 of rigid tubular member 12 not being immersed in the selected liquid. The pressure in the liquid at the first tubular member end 16 of rigid tubular member 12 is greater than the atmospheric pressure at the second tubular member end 18 of rigid tubular member 12 as is known from basic principles of physics. The pressure differential causes the fluid to flow upward into reservoir cavity 14 by capillary action.

Reversible sealing means 24 is then adhesively applied to

rigid tubular member 12 so as to completely seal aperture 20. Preferably reversible sealing means 24 includes tab means 26 integral therewith, which tab means 26 is not adhesively applied to rigid tubular member 12, thereby providing the user 5 means for easily unsealing reversible sealing means 24 by pulling on tab means 26.

Rigid tubular member 12 preferably is then removed from the container of liquid, which may cause a small volume of the liquid to flow out of the first tubular member end 16 of rigid 10 tubular member 12 until forces of the surface tension between the liquid and the inner surface of reservoir cavity 14 and the pressure differential between the first end 16 and the second tubular member end 18 of rigid tubular member 12 exceed the force of gravity acting on the liquid. The remainder of 15 the liquid in reservoir cavity 14 will be retained therein until reversible sealing means 24 is unsealed.

After rigid tubular member 12 is removed from the selected liquid, an absorbent material 22 may be attached to the first tubular member end 16 of rigid tubular member 12 by 20 conventional means.

In this preferred embodiment of an applicator according to the present invention, after the steps described above have been completed, saturable swab applicator 10 preferably may be enclosed in antidesiccation sealing means 30, which may be a 25 pouch of plastic or other material which is reversibly sealable at its edges and which protects applicator 10 from losing its liquid by desiccation. Applicator 10 and antidesiccation sealing means 30 may be made of materials capable of being sterilized by sterilization means known in 30 the art.

When saturable swab applicator 10 is to be used, antidesiccation sealing means 30 may be unsealed and applicator 10 removed. Tab means 26 may be pulled by the user to break the adhesion between reversible sealing means 24 and 35 the outer surface of rigid tubular member 12 so as to expose reservoir cavity 14 to atmospheric pressure via aperture 20. The sudden equalization of pressure between the first tubular

~~member end 16~~ and the second tubular member end 18 of rigid tubular member 12 causes the liquid contained in reservoir cavity 14 to flow rapidly out of the first tubular member end 16 to saturate absorbent material 22 without the need for  
5 compressing the apparatus, rupturing fixed seals or forcing the liquid out by pushing on a plunger. The applicator 10 is thus prepared to be used to apply the selected liquid to a surface, such as a patient's skin.

FIGURE 2 shows a variation of the first embodiment of the  
10 present invention. Components common to FIGURES 1A, 1B and 2 are indicated by identical numbers. The structure of the invention shown in FIGURE 2 is similar to that shown in FIGURE 1 except that antidesiccation means 30 is incorporated into reversible sealing means 25. Reversible sealing means 25  
15 preferably is an airtight and moisture proof envelope sealable at its edges similar to antidesiccation means 30 of FIGURE 1. The functions of reversible sealing means 24 and antidesiccation means 30 of FIGURE 1 are performed in the device of FIGURE 2 by reversible sealing means 25.

20 In operation, before reversible sealing means 25 is applied to seal applicator 10, first tubular member end 16 preferably is immersed in a volume of a selected liquid and rigid tubular member 12 is filled as described above in relation to FIGURE 1. Reversible sealing means 12 is then  
25 progressively applied to seal rigid tubular member 12, beginning at second tubular member end 18 and progressing toward first tubular member end 16. When aperture 20 has been sealed by reversible sealing means 25, applicator 10 may be removed from the volume of liquid, a portion of which is  
30 retained in reservoir cavity 14. An absorbent material 22 may be attached by conventional means to the first tubular member end 16 and reversible sealing means 25 may be applied to the remainder of applicator 10 to enclose absorbent material 22.  
~~The sealing of reversible sealing means 25~~ not only enables  
35 the retention of liquid in reservoir cavity 14 by sealing aperture 20, but also provides means for preventing desiccation of the liquid by exposure to the air.

12.

When applicator 10 is to be used, reversible sealing means 25 may be progressively peeled apart, preferably beginning at the absorbent material 22 and progressing toward the second tubular member end 18. When aperture 20 thereby becomes unsealed, the liquid in reservoir cavity 14 is exposed to atmospheric pressure and the liquid flows into absorbent material 22.

As an alternative means for filling reservoir cavity in any or all of the embodiments within the scope of the present invention, a liquid may be injected, as by a syringe or other device, into reservoir cavity 14. The structure and principles of operation of applicator 10 as so filled remain the same as when reservoir cavity 14 is filled in the manner described in relation to FIGURES 1 and 2 above.

15 A second embodiment of the saturable swab applicator 10 according to the present invention is shown in FIGURES 3A and 3B. In that embodiment, the components may be similar to those of FIGURES 1A and 1B except for reversible sealing means 24. In the second embodiment, reversible sealing means 24 includes a plug 32 which reversibly seals aperture 20 and which preferably is, but need not be, hinged by hinging means 34, a first end 36 of which is attached to or is integral with rigid tubular member 12. A second end 38 of hinging means 34 is attached to plug 32. A wax or other sealing substance, not 25 shown in FIGURES 3A or 3B, may be applied to the perimeter of plug 32 as additional assurance of maintenance of the reversible seal until it is desired to unseal the apparatus.

The operation of the second embodiment of the saturable swab applicator 10 is similar to that described above in 30 regard to the first embodiment of the present invention.

While reversible sealing means 24 is in an unsealed position, shown as 24' in FIGURE 3A, the first tubular member, end 16 of rigid tubular member 12 preferably is immersed in a selected liquid, causing a volume of the liquid to flow into reservoir 35 cavity 14. Reversible sealing means 24 is then placed in the sealed position, as by pressing the plug into aperture 20. After removal of rigid tubular member 12 from the liquid,

absorbent material 22 is attached to the open first tubular member end 16 and, preferably, antidesiccation sealing means 30, not shown in FIGURES 3A or 3B, is applied over applicator 10 as described above in regard to the first embodiment of the present invention.

When the applicator 10 is to be used, antidesiccation means 30, not shown in FIGURE 3A or 3B, is removed and plug 32 is removed to expose the fluid contained in reservoir cavity 14 to atmospheric pressure. This causes the liquid to flow rapidly out of the first tubular member end 16 of rigid tubular member 12 to saturate absorbent material 22.

FIGURES 4A, 4B and 4C show a third embodiment of an applicator 10 according to the present invention. The structure of this embodiment is similar to the structure described above in regard to a first and a second embodiment. In the third embodiment, reversible sealing means 24 includes a rotatable collar 40 rotatably and tightly applied around rigid tubular member 12 in the area of aperture 20 and retaining means 42 which retains rotatable collar 40 in the area of aperture 20. As shown in FIGURES 4A and 4B, rotatable collar 40 includes a collar aperture 44 extending radially through a portion of rotatable collar 40.

With rotatable collar 40 in the unsealed position shown in FIGURE 4B, wherein collar aperture 44 is disposed in radial alignment with aperture 20 of rigid tubular member 12, the first tubular member end 16 of rigid tubular member 12 preferably is immersed in a selected liquid and a volume of that liquid flows upward into reservoir cavity 14. Rotatable collar 40 is then rotated to the sealed position shown in FIGURE 4C, such that collar aperture 44 is not radially aligned with aperture 20 in rigid tubular member 12.

Rotatable collar 40 preferably is sufficiently tightly applied to rigid tubular member 12 that no further seal is required to ensure that aperture 20 remains completely sealed until the user desires to unseal it. However, collar sealing means 46, which may be a wax or other sealing material, may also be applied to rotatable collar 40 to further ensure complete

sealing of reservoir cavity 14.

Rigid tubular member 12 is then removed from the liquid, retaining a volume of the liquid in reservoir cavity 14, and absorbent material 22 is attached to the first end 16 of rigid tubular member 12. Antidesiccation sealing means 30, shown in FIGURES 1A and 1B, preferably is applied to applicator 10 in this embodiment as described above in regard to the first embodiment.

FIGURES 5A and 5B are longitudinal cross sections of a fourth embodiment of a saturable swab applicator 10 according to the present invention. The structure and operation of this embodiment are similar to those of the applicator 10 shown in FIGURE 4A, except that reversible sealing means 24 is not a rotatable collar 40. In the fourth embodiment, reversible sealing means 24 is a sliding cap 41 which is shown in a first closed or sealed position in FIGURE 5A and in a second open or unsealed position in FIGURE 5B. Sliding cap 41 preferably includes a collar portion 43, preferably extending continuously around and being closely applied to the circumference of rigid tubular member 12 proximate second tubular member end 18, and a cap end portion 45 formed continuously with the collar portion 43. Preferably, applicator 10 includes a cap stop 47 which may be a raised ridge extending substantially around the circumference of tubular member 12 between aperture 20 and second tubular member end 18. Cap stop 47 prevents the complete removal of sliding cap 41 when in the unsealed position shown in FIGURE 5B. This provides convenient means to prevent loss of sliding cap 41, but is not required for proper operation of applicator 10 according to the present invention.

The filling of reservoir cavity 14 in this embodiment is accomplished as described above in relation to other embodiments. Sliding cap 41 is initially in the unsealed position until fluid enters reservoir cavity 14, at which time sliding cap 41 is moved toward first tubular member end 16, thereby sealing aperture 20. When applicator 10 is to be used, sliding cap 41 is moved toward second tubular member end



~~18, thereby unsealing aperture 20 and exposing the liquid contained in reservoir cavity 14 to atmospheric pressure. The liquid is thereby caused to flow out of reservoir cavity 14 to saturate absorbent material 22.~~

5        A fifth embodiment of a saturable swab applicator 10 according to the present invention is shown in FIGURES 6A and 6B. The structure and operation of this embodiment are similar to those of the first, second, third and fourth embodiments described above, except for reversible sealing means 24.

      In the fifth embodiment, reversible sealing means 24 includes a necked-down region 48 extending from the inner edge 50 of aperture 20 to a central button 52 which may have the same or a different thickness than the thickness of rigid 15 tubular member 12. Necked-down region 48 may be frangible at all or at some points, such that pressure applied to the button region 52 causes at least a portion of the necked-down portion 48 to fracture, allowing atmospheric pressure to be applied to the liquid contained in rigid tubular member 12.

20        If necked-down region 48 is not frangible at all points, when pressure is applied to central button 52, central button 52 remains partially attached, as by a hinge, to a portion of the inner edge 50 of aperture 20. This prevents central button 52 from dropping into reservoir cavity 14 or onto, for 25 example, a surgical field, where it is undesirable. Similar components have been used in the construction of beverage cans which require a seal that may be unsealed by application of pressure.

      A sixth embodiment of saturable swab applicator 10 30 according to the present invention is shown in FIGURE 7. In that embodiment, the components may be similar to those shown in the previous figures, except for the structure and operation of reversible sealing means 24. In the sixth embodiment, reversible sealing means 24 includes a frangible 35 necked-down portion 54 of rigid tubular member 12 disposed proximate second tubular member end 18 and initial seal means 56. Frangible necked-down portion 54 may be of lesser

thickness than the adjacent portions of rigid tubular member 12, and may extend entirely around rigid tubular member 12 or partly around rigid tubular member 12. Initial seal means 56 may be a plug, hinged or unhinged, such as that described above in relation to the second embodiment of the present invention. Initial seal means 56 may be disposed directly at the terminus 58 of rigid tubular member 12 as shown in FIGURE 7, or at another location proximate the second tubular member end 18. Initial seal means 56 reversibly seals aperture 20.

10 Rigid tubular member 12 of the sixth embodiment of the present invention is formed by extrusion, molding, etc. as described above, but includes frangible necked down portion 54, which is fabricated in the sealed configuration. Initial seal means 56 is initially in the unsealed position, i.e., not  
15 sealing aperture 20. First tubular member end 16 preferably is immersed in a selected liquid and the liquid flows into reservoir cavity 14, as described above. Initial seal means 56 is then placed in the sealed position, e.g. by inserting the plug into aperture 20, and rigid tubular member 12 is  
20 removed from the liquid and absorbent material 22 is attached to first tubular member end 16.

When saturable swab applicator 10 of the sixth embodiment of the present invention is to be used, initial seal means 56 remains sealed and frangible necked-down portion 54 is broken  
25 by the user by snapping. If frangible necked-down portion 54 extends entirely around rigid tubular member 12, then the section of rigid tubular member 12 that includes second tubular member end 18 is completely removable from the rest of rigid tubular member 12. If frangible necked-down portion 54  
30 extends only partly around rigid tubular member 12, then the snapping by the user of frangible portion 54 results in continuing partial attachment of the section of rigid tubular member 12 that includes second tubular member end 18 to the rest of rigid tubular member 12.

35 The snapping by the user of frangible necked-down portion 54 allows atmospheric pressure to be applied to the liquid contained in reservoir cavity 14, causing the liquid to flow

rapidly out of first tubular member end 16 into absorbent material 22. Applicator 10 is then ready for use to apply medicaments, dyes, or other liquids to a surface.

A seventh embodiment of a saturable swab applicator 10 according to the present invention is shown in FIGURE 8. In that embodiment, two applicators 10 and 10' are joined at their respective second tubular member ends 18 and 18' with a permanent separator wall 60 disposed therebetween to prevent contact or admixture of the liquids contained in reservoir 10 cavities 14 and 14'. Applicators 10 and 10' may be formed integrally, as by molding, or may be formed separately and then joined with an adhesive applied between second tubular member ends 18 and 18'.

Each of applicators 10 and 10' includes reversible 15 sealing means 24 or 24', indicated generally in FIGURE 8, which may be any of the types of reversible sealing means 24 described above in relation to the other embodiments of this invention. In this embodiment, reversible sealing means 24 may be the same or different than reversible sealing means 20 24'.

The operation of this embodiment is similar to the operation of the other embodiments, with the noted variations according to the particular type of reversible sealing means 24 which is used in applicators 10 and 10'. While reversible 25 sealing means 24 is in the unsealed position, first tubular member end 16 is immersed in a liquid and the liquid flows upward into reservoir cavity 14. Reversible sealing means 24 is then put into its sealed position and rigid tubular member 12 is removed from the liquid. A similar operation is 30 performed on rigid tubular member 12'.

Absorbent material 22 may be attached to first tubular member end 16 either before or after the filling of reservoir cavity 14'. Absorbent material 22' is attached to first tubular member end 16' after reservoir cavity 14' is filled 35 and rigid tubular member 12' is removed from the liquid. The liquid contained in reservoir cavity 14 may be the same or different than the liquid contained in reservoir cavity 14'.

A eighth embodiment of a saturable swab applicator according to the present invention is shown in FIGURE 9. In that embodiment, a plurality of individual applicators represented generally as 10 A-D are joined by a common manifold means 62. Four applicators 10 A-D are shown for representative purposes and FIGURE 9 does not imply any limitation on the number of applicators 10 which may be so joined.

Each of applicators 10 A-D may include reversible sealing means of a type different than or the same as one or more of the other ones of applicators 10 A-D. For example, applicator 10A may include the taped configuration described above in relation to the first embodiment of the present invention, and applicator 10 B may be of the rotatable cuff configuration described above in relation to the third embodiment of the present invention, and so on.

Common manifold means 62 in this embodiment may include a strip or bar or tube of rigid, semi-rigid or flexible material to which second tubular member ends 18 A-D are joined by integral molding therewith or by other common means of attachment. Second tubular member ends 18 A-D may be joined directly to common manifold means 62 or may be joined to common manifold means 62 by connectors 64 A-D, which may be of any desired length. Common manifold means 62 and connectors 64 A-D may be hollow or solid.

Common manifold means 62 provides the user of the present invention access to an orderly array of individually usable saturable swab applicators 10 A-D. When each applicator 10 is needed, it is snapped off from common manifold means 62 and used as described above, with variations depending on the particular embodiment of each applicator 10.

This array is advantageous especially in settings where a high degree of organization and speed of access to the applicators is desired, as for example, in surgical suites or in emergency rooms. The array also provides wearers of surgical gloves an easier way to select and grasp applicators 10 than would be available when each applicator 10 is separate

from others. Even in non-critical settings, the orderliness of the array prevents individual applicators from being lost or damaged.

FIGURE 10 is a side view of a ninth embodiment of an applicator 10 according to the present invention. A plurality of individual applicators 10A-D is represented generally in FIGURE 10 and the reversible sealing means of manifold means 62 includes reversible seal piercing means 63. Piercing means 63 provides convenient means for puncturing tubular members 12A-D proximate second tubular member ends 18A-D after rigid tubular members 12A-D are removed from manifold means 62 by fracturing connectors 64A-D. One, several, or all of rigid tubular members 12A-D may be removed from manifold means 62 to expose liquid contained in the reservoir cavities, not shown in FIGURE 10, to atmospheric pressure, thereby causing the liquid to flow into and saturate absorbent material 22-D.

An tenth embodiment of a saturable swab applicator according to the present invention is shown in FIGURES 11A and 11B. In FIGURE 11A, a plurality of applicators 10 A-D are shown, including rigid tubular members 12 A-D, having reservoir cavities 14 A-D, open first tubular member ends 16 A-D and second open tubular member ends 18 A-D, respectively. Four applicators 10 A-D are shown for representative purposes and FIGURE 11A does not imply any limitation on the number of applicators 10 that might be included in this embodiment of the present invention.

This embodiment includes rigid manifold sealing means 66 which includes a rigid continuous hollow tube whose internal manifold cavity 68 extends substantially the length of manifold sealing means 66. Manifold sealing means 66 is sealed at a first manifold end 70 and a second manifold end 70 and may be formed by molding or other commonly available industrial manufacturing means. Rigid tubular members 12 A-D are joined to manifold sealing means 66 at second open tubular ends 18 A-D and internal manifold cavity 68 is continuous with reservoir cavities 14 A-D. Rigid tubular members 12 A-D may be formed integrally with manifold sealing means 66 or may be

attached thereto by commonly available attaching means.

Manifold sealing means 66 includes reversible sealing means 24, represented generally in FIGURE 11A. Reversible sealing means 24 may include any type of sealing means 55 according to the present invention, including those described above in relation to the other embodiments, e.g. taping means, rotatable collar means, etc. Reversible sealing means 24 may be disposed anywhere along the length of manifold sealing means 66.

10 In this embodiment of the present invention, reversible sealing means 24 of manifold sealing means 66 is initially in the unsealed position as described above in relation to the other embodiments and one or more of first rigid tubular member ends 16 A-D may be immersed in a selected liquid, 15 causing the liquid to flow upward into reservoir cavities 14 A-D. Reversible sealing means 24 is then placed in the sealed position, according to the procedure described above in relation to the particular type of reversible sealing means 24 chosen. Rigid tubular members 12 A-D are then withdrawn from 20 the liquid and absorbent materials 22 A-D are then attached thereto, as described above. Preferably, the entire array of connected applicators 10 A-D is sealed in antidesiccation sealing 30, such as a sealable pouch, not shown in FIGURE 11A, to prevent desiccation of the liquid contained in the 25 applicators 10 A-D.

When the applicators 10 A-D are to be used, antidesiccation sealing means 30, not shown, is removed and reversible sealing means 24 is placed in its unsealed position, according to the procedure described above in regard 30 to the particular reversible sealing means used. This allows atmospheric pressure to be applied to the second tubular member ends 18 A-D simultaneously, causing the liquid contained in reservoir cavities 14 A-D to flow out of first tubular member ends 16 A-D so that absorbent materials 22 A-D 35 become saturated simultaneously.

Each of individual applicators 10 A-D may be snapped off from manifold sealing means 66 for separate use, or the

applicators 10 A-D may remain attached to manifold sealing means 68 which may serve as a handle for simultaneous use of all applicators 10 A-D. This embodiment is particularly advantageous in settings, such as emergency rooms, where several applicators 10 may be needed in a short time, and where the flexibility of being able to use the applicators 10 one by one or all together is desired.

A variation of this embodiment of the present invention is shown in FIGURE 11B. The structure and operation of this variation are substantially the same as shown and described in relation to FIGURE 11A. However, it may be advantageous to divide internal manifold cavity 68 into two or more cavity sections 74 A-B by forming manifold sealing means 66 with one or more manifold cavity partition plugs 76 which completely seal one cavity section 74 from every other cavity section 74.

When this configuration is chosen, more than one reversible sealing means 24 A-B must be used, one for each cavity section 74. Each cavity section 74 may be continuous with one or more reservoir cavities 14 A-D, such that unsealing of one reversible sealing means 24 causes some, but not all, of the absorbent materials of applicators 10 A-D to be saturated with the selected liquid. Also, the liquid in each of the cavity sections 74 A-B may be the same as or different than the liquid in the other cavity sections 74 A-B.

In all of the embodiments of the present invention which include a plurality of rigid tubular members 12, each rigid tubular member 12 may have a length and a diameter, and therefore a volume, which is the same as or is different from the length, diameter and volume of other rigid tubular members 12 in the applicator 10.

It is to be understood that although several preferred embodiments of the present invention have been illustrated and described, various modifications, alternatives and equivalents will become apparent to those skilled in the art and, accordingly, the scope of the present invention should be defined only by the appended claims and equivalents thereof.

The Claims

We claim:

1. An applicator comprising:

at least one rigid, non-compressible tubular member  
5 having an open first tubular member end, a closed second  
tubular member end and a reservoir cavity for temporarily  
containing a selected liquid, said reservoir cavity being  
disposed in and extending from said first tubular member end  
to said second tubular member end and having a diameter such  
10 that said selected liquid can flow by capillary action into  
said reservoir cavity when said first tubular member end is  
immersed in a volume of said selected liquid;

an aperture extending through the thickness of a wall of  
said tubular member proximate said second tubular member end,  
15 said aperture enabling atmospheric pressure to be applied to  
said liquid contained in said reservoir cavity when said  
aperture is unsealed;

reversible sealing means for reversibly sealing said  
aperture, said reversible sealing means having a sealed  
20 position such that said aperture is sealed and an unsealed  
~~position such that said aperture is unsealed; and~~

an absorbent swab attached to said first tubular member  
end for absorbing said liquid from said reservoir cavity when  
said reversible sealing means is in said unsealed position and  
25 for applying said liquid to a surface.

2. The applicator of Claim 1 further including  
antidesiccation means for preventing desiccation of said  
liquid when said liquid is contained in said reservoir cavity.

3. The applicator of Claim 2 wherein said  
30 antidesiccation means includes an air and liquid impermeable  
sheath sealably enclosing said applicator.

4. The applicator of Claim 1 wherein said reversible  
sealing means includes an air and liquid impermeable plug  
inserted in said aperture such that said aperture is sealed,  
35 said plug being removable from said aperture.

5. The applicator of Claim 4 further including hinge  
means for hinging said plug to said tubular member.



6. The applicator of Claim 1 wherein said reversible sealing means includes an air and liquid impermeable rotatable collar rotatably and tightly disposed around the circumference of a portion of said tubular member, said rotatable collar having a collar aperture extending radially therethrough, such that said rotatable collar may be rotated to a first position wherein said collar aperture is aligned with said aperture of said tubular member thereby placing said aperture in an unsealed position such that atmospheric pressure may be applied therethrough to said liquid contained in said reservoir cavity and such that said rotatable collar may be rotated to a second position wherein said collar aperture is not aligned with said aperture of said tubular member thereby placing said aperture in a sealed position.

7. The applicator of Claim 6 further including collar sealing means for reversibly sealing said rotatable collar to said tubular member.

8. The applicator of Claim 7 wherein said collar sealing means includes a wax coating covering said rotatable collar.

9. The applicator of Claim 1 wherein said reversible sealing means includes air and liquid impermeable cap means having a collar portion slidably and sealably applied around the circumference of said rigid tubular member, said cap means having a first position such that said aperture is sealed by said collar portion and a second position such that said aperture is unsealed.

10. The applicator of Claim 4 further including a frangible necked-down portion of a wall of said tubular member proximate said second tubular member end having a reduced thickness such that said necked-down portion may be fractured by applying snapping pressure thereto such that atmospheric pressure may be applied to said liquid contained in said reservoir cavity.

11. The applicator of Claim 10 wherein said frangible necked-down reduced thickness portion extends entirely around the circumference of said tubular member.

12. The applicator of Claim 10 wherein said frangible

necked-down reduced thickness-portion extends substantially around the circumference of said tubular member.

13. The applicator of Claim 10 wherein said frangible necked-down portion includes button means disposed therein and 5 formed integrally therewith, said button means having a greater thickness than the thickness of said necked-down portion, such that mechanical pressure applied to said button means causes said necked-down portion to fracture such that atmospheric pressure may be applied to said liquid contained 10 in said tubular member.

14. The applicator of Claim 1 having a plurality of said rigid, non-compressible tubular members and further comprising manifold means for interconnecting said tubular members, said manifold means including connector means for frangibly 15 attaching said second tubular member ends to said manifold means.

15. The applicator of Claim 14 wherein said connector means is frangible.

16. The applicator of Claim 14 wherein said manifold 20 means and said connector means are integrally formed with said rigid tubular members.

17. The applicator of Claim 1 wherein said second tubular member ends of two of said rigid tubular members are joined together in abutting relation, said two tubular members 25 sharing a common longitudinal axis.

18. The applicator of Claim 17 wherein said two rigid tubular members are integrally formed.

19. The applicator of Claim 17 wherein said two rigid tubular members are joined by an adhesive disposed between 30 said second tubular member ends.

20. The applicator of Claim 1 wherein said reversible sealing means includes a length of an air and liquid impermeable tape adhesively applied to the outer surface of said rigid tubular member such that said aperture is 35 reversibly sealed.

21. The applicator of Claim 20 further including tab means integrally formed with said tape for pulling to remove

~~said tape from adhesive application to said rigid tubular member.~~

22. An applicator comprising:

a plurality of rigid, non-compressible tubular members  
55 each having an open first tubular member end, an open second  
tubular member end, and a reservoir cavity for temporarily  
containing a selected liquid, said reservoir cavity extending  
the entire length of said tubular member between said first  
and second tubular member ends and having a diameter such that  
10 said selected liquid can flow by capillary action into said  
reservoir cavity when said first tubular member end is  
immersed in a volume of said liquid;

manifold means for interconnecting at least two of said  
reservoir cavities, said manifold means including a hollow  
15 tube having an internal manifold cavity, a first sealed end  
and ~~a second sealed end~~, manifold connector means for  
connecting each of said reservoir cavities to said internal  
manifold cavity of said manifold means, and at least one  
manifold aperture extending through the thickness of a wall of  
20 said tubular member, each of said manifold apertures enabling  
~~atmospheric pressure to be applied therethrough to said liquid~~  
contained in said reservoir cavities;

reversible sealing means for reversibly sealing each of  
said manifold apertures, said reversible sealing means having  
25 a sealed position such that at least one of said manifold  
apertures is sealed and an unsealed position such that at  
least one of said apertures is unsealed; and

an absorbent swab attached to each of said first tubular  
member ends for absorbing said liquid from said reservoir  
30 cavities when said reversible sealing means is in said  
unsealed position and for applying said liquid to a surface.

23. The applicator of Claim 22 wherein said manifold  
means further includes piercing means for piercing said  
~~reversible sealing means such that atmospheric pressure can be~~  
35 applied to said liquid in said reservoir cavity.

24. The applicator of Claim 22 having a plurality of  
manifold apertures and further including at least one air and

liquid impermeable manifold cavity partition plug for dividing said manifold cavity into at least two cavity sections, said partition plug completely separating said cavity sections, and at least one of said reservoir cavities being continuous with 5 each of said cavity sections.

25. The applicator of Claim 22 further including antidesiccation means for preventing desiccation of said liquid when said liquid is contained in said reservoir cavity.

26. The applicator of Claim 25 wherein said 10 antidesiccation means includes an air and liquid impermeable sheath sealably enclosing said applicator.

27. The applicator of Claim 22 wherein said reversible sealing means includes an air and liquid impermeable plug inserted in said aperture such that said aperture is sealed, 15 said plug being removable from said aperture.

28. The applicator of Claim 27 further including hinge means for hinging said plug to said tubular member.

29. The applicator of Claim 22 wherein said reversible sealing means includes an air and liquid impermeable rotatable 20 collar rotatably and tightly disposed around the circumference of a portion of said tubular member, said rotatable collar having a collar aperture extending radially therethrough, such that said rotatable collar may be rotated to a first position wherein said collar aperture is aligned with said aperture of 25 said tubular member thereby placing said aperture in an unsealed position such that atmospheric pressure may be applied therethrough to said liquid contained in said reservoir cavity and such that said rotatable collar may be rotated to a second position wherein said collar aperture is 30 not aligned with said aperture of said tubular member thereby placing said aperture in a sealed position.

30. The applicator of Claim 22 wherein said reversible sealing means includes an air and liquid impermeable cap means having a collar portion slidably and sealably applied around 35 the circumference of said rigid tubular member, said cap means having a first position such that said aperture is sealed by said collar portion and a second position such that said

aperture is unsealed.

31. The applicator of Claim 29 further including collar sealing means for reversibly sealing said rotatable collar to said tubular member.

5 32. The applicator of Claim 31 wherein said collar sealing means includes a wax coating covering said rotatable collar.

33. The applicator of Claim 29 further including a frangible necked-down reduced thickness portion of a wall of  
10 said tubular member proximate said second tubular member end having a reduced thickness such that said necked-down portion may be fractured by applying snapping pressure thereto such that atmospheric pressure may be applied to said liquid contained in said reservoir cavity.

15 34. The applicator of Claim 33 wherein said frangible necked-down reduced thickness portion extends entirely around the circumference of said tubular member.

35. The applicator of Claim 33 wherein said frangible necked-down reduced thickness portion extends substantially  
20 around the circumference of said tubular member.

36. The applicator of Claim 33 wherein said frangible necked-down portion includes button means disposed therein and formed integrally therewith, said button means having a greater thickness than the thickness of said necked-down  
25 portion, such that mechanical pressure applied to said button means causes said necked-down portion to fracture such that atmospheric pressure may be applied to said liquid contained in said tubular member.

37. A method for making and using a saturable swab  
30 applicator comprising the steps of:

filling a rigid, non-compressible tubular member having a first end and a second end with a volume of a liquid;

creating a pressure differential between said first end and said second end of said tubular member such that said  
35 liquid is retained in said tubular member; and

attaching an absorbent material to said first end of said tubular member.

38. The method of claim 37 further including the steps of:

destroying said pressure differential between said first end and said second end of said tubular member such that said liquid flows from said tubular member into said absorbent material.

39. A method for making and using an applicator comprising the steps of:

10 inserting an open first end of a rigid, non-compressible tubular member into a volume of a selected liquid with a second end of said tubular member being exposed to atmospheric pressure, such that a quantity of said liquid flows by capillary action into said tubular member;

sealing said second end of said tubular member;

15 removing said first tubular member end from said volume of liquid; and

attaching an absorbent material to said first tubular member end.

40. The method of Claim 37 further comprising the step 20 of:

sealing said applicator in sealable antidesiccation means such that desiccation of said liquid in said tubular member is prevented.

41. The method of Claim 39 further including the step 25 of:

sealing said applicator in sealable antidesiccation means such that desiccation of said liquid in said tubular member is prevented.

42. The method of Claim 37 further comprising the steps 30 of:

unsealing said second tubular member end such that said liquid in said tubular member is exposed to atmospheric pressure and such that said liquid flows out from said first tubular member end; and

35 saturating said absorbent material with said liquid flowing out from said first tubular member end.

43. The method of Claim 40 further comprising the steps

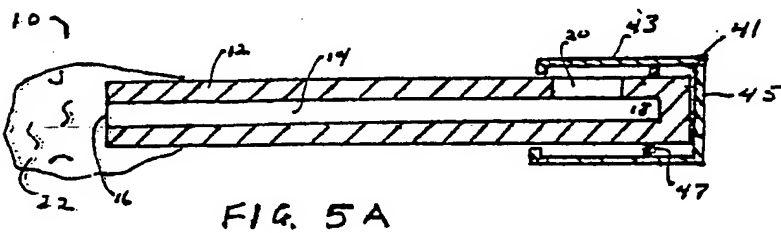
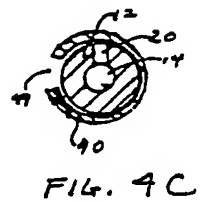
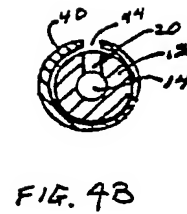
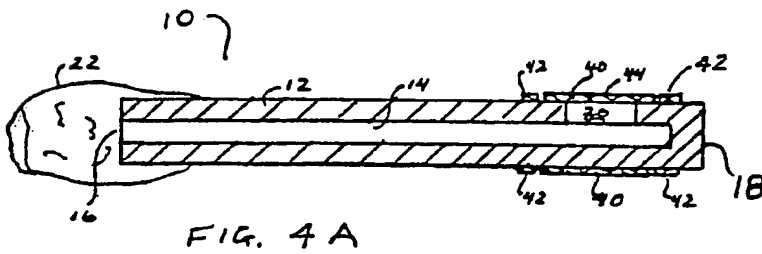
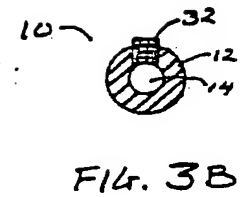
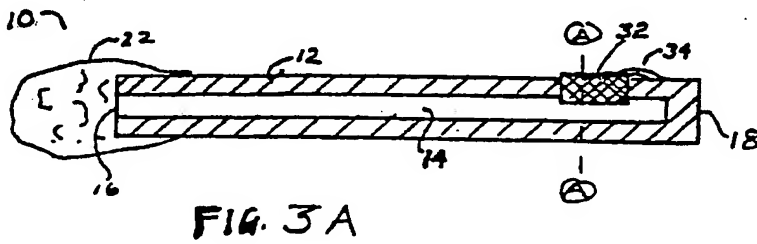
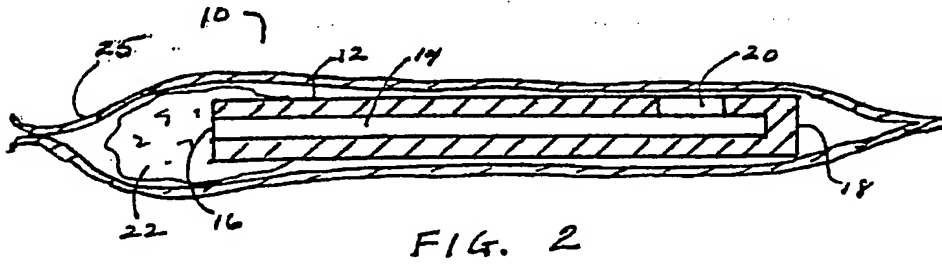
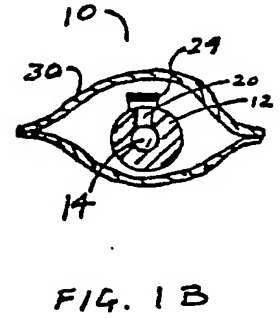
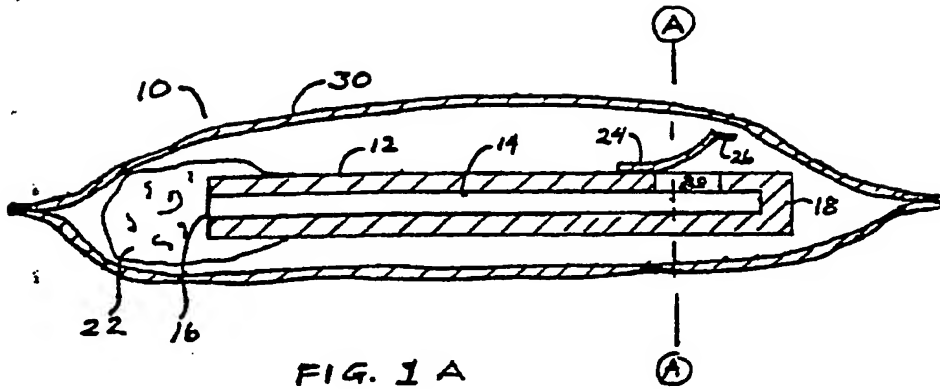
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removing said sealable antidesiccation means from said applicator;

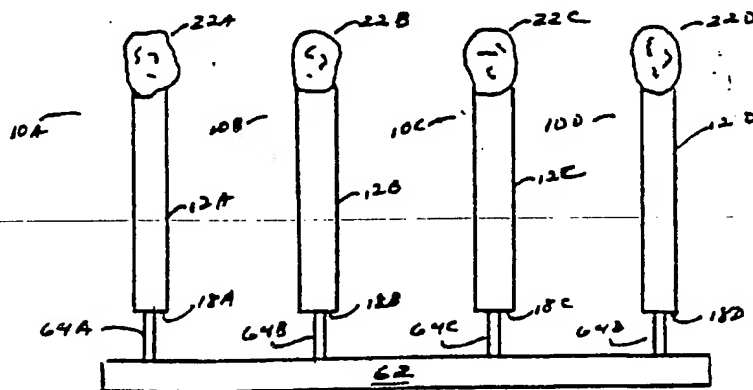
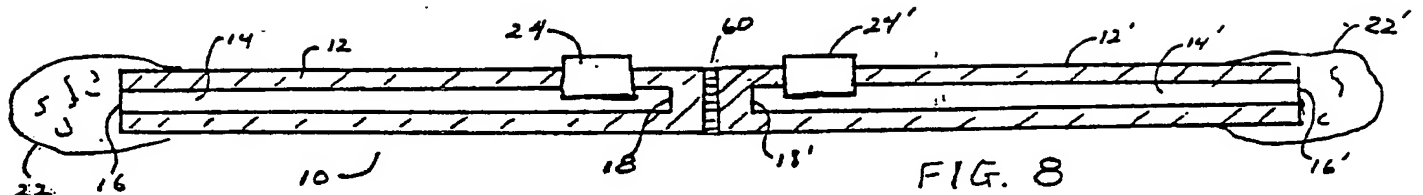
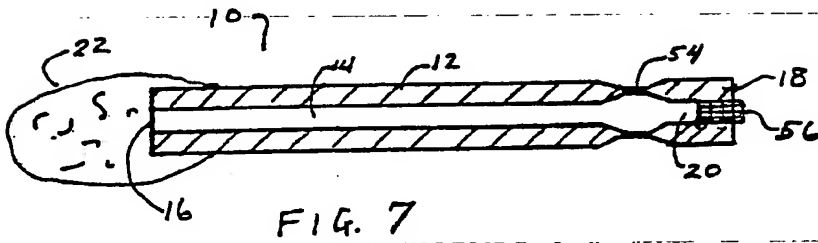
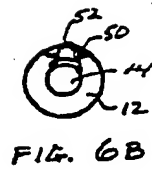
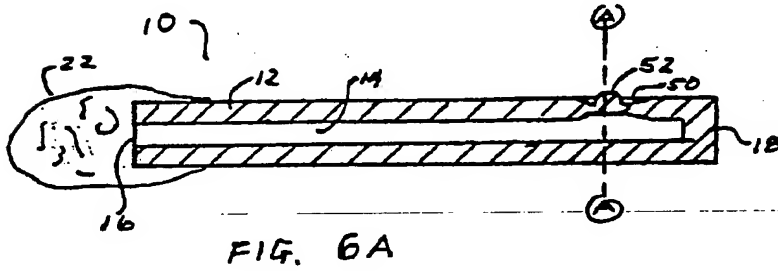
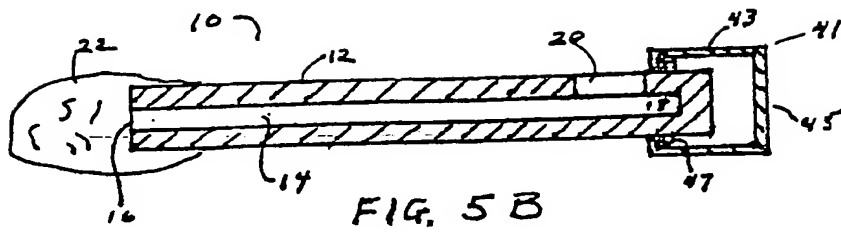
unsealing said second tubular member end such that said  
5 liquid in said tubular member is exposed to atmospheric pressure and such that said liquid flows out from said first tubular member end;

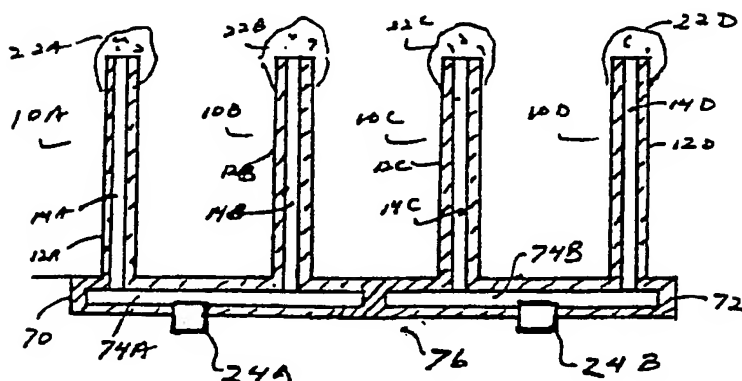
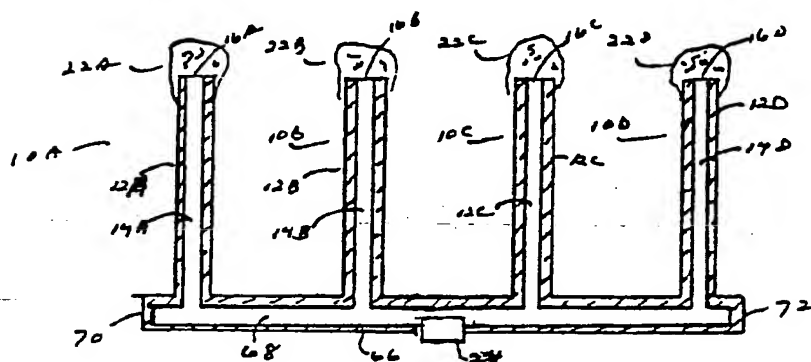
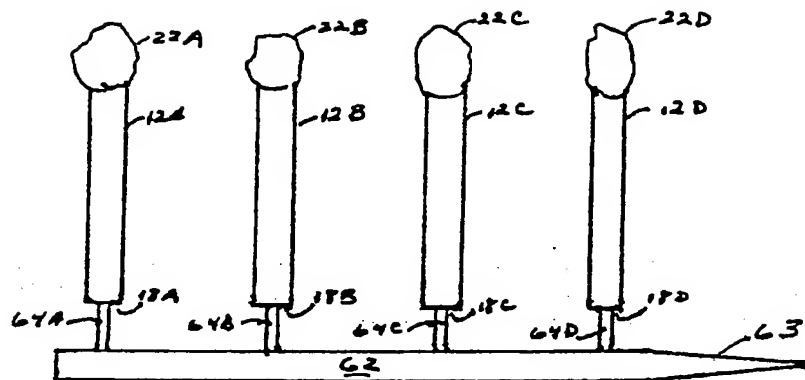
saturating said absorbent material with said liquid flowing out from said first tubular member end; and

10 applying said liquid saturating said absorbent material to a surface.









# INTERNATIONAL SEARCH REPORT

International Application No PCT/US89/01603

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC (4) A61M 35/00		
US.C1. 604/3, 310 401/132, 196		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
U.S.	604/1, 2, 3, 244, 306, 310 401/132, 133, 134, 135, 136, 137, 138, 177, 196, 197, 198, 199	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup></b>		
Category <sup>*</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X Y	US,A, 3,958,571, (BENNINGTON) 25 May 1976. See the entire document.	1,4,10-12,20-21 37-38,42
Y	US,A, 2,902,146 (DOHERTY) 01 September 1959. See the entire document.	2-3,5-9,13-19, 22-36,39-41,43
Y	US,A, 3,757,782 (AIKEN) 11 September 1973. See the entire document.	2-3,25-36,40-41 43
Y	US,A, 3,295,537 (YOUNG, JR.) 03 January 1967. See the entire document.	17-19,24
Y,P	US,A, 4,799,815 (BARABINO ET AL) 24 January 1989. See the entire document.	14-16,22-36
A,P	US,A, 4,740,194 (BARABINO ET AL) 26 April 1988. See the entire document.	23
A	US,A, 4,183,328 (LAWRENCE) 15 January 1980. See the entire document.	1-43
A	US,A, 4,218,155 (WEIDNER) 19 August 1980. See the entire document.	14-16,22-36
A	US,A, 4,183,684 (AVERY, JR.) 15 January 1980. See the entire document.	1-43
A,P	US,A, 4,747,719 (PARKIN) 31 May 1988. See entire document.	1-43
<p><sup>*</sup> Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
27 May 1989	05 JUL 1989	
International Searching Authority	Signature of Authorized Officer	
ISA/US	Angela D. Sykes Angela Sykes	

Form PCT/ISA/210 (second sheet) (Rev.11-87)